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NON-COMBAT FIRES IN ARMY GROUND VEHICLES.(U)
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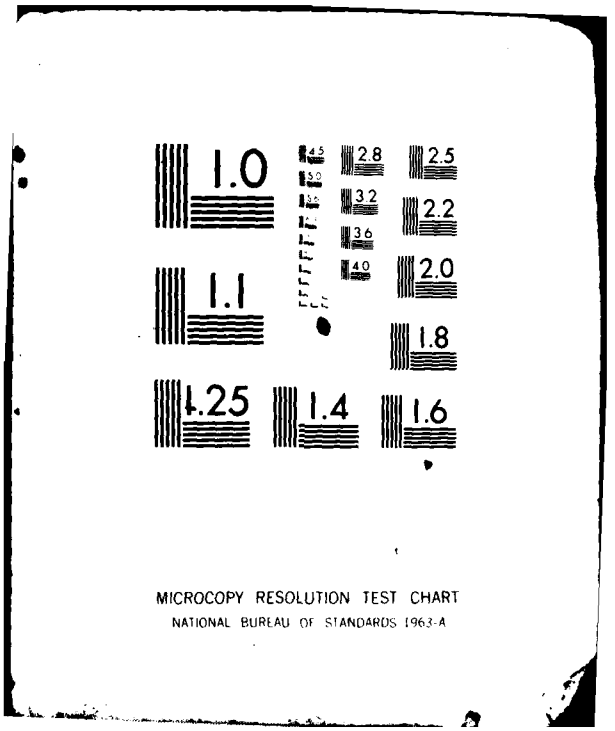
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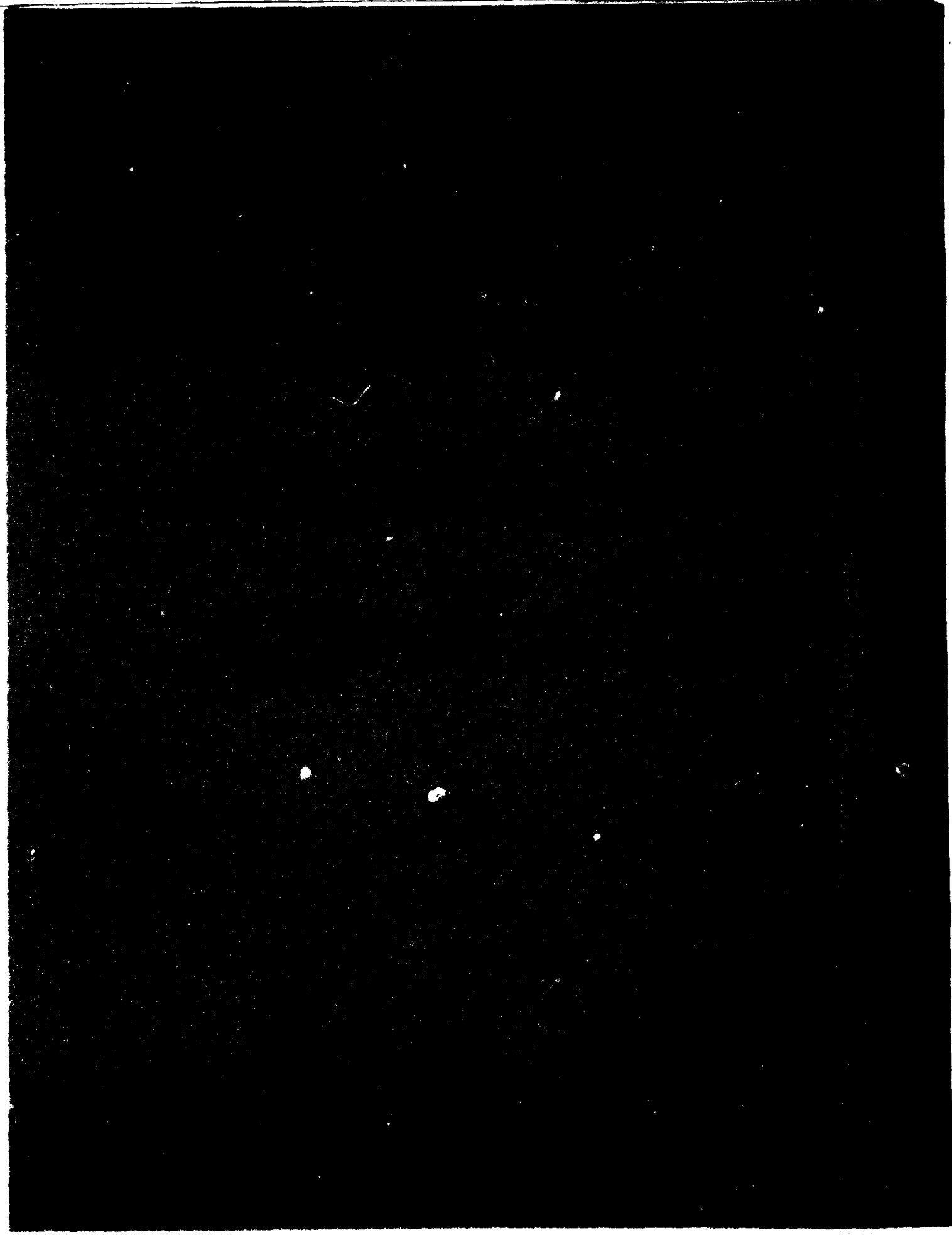

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The primary objective of this effort was to investigate the existing data relative to non-combat fires in Army ground vehicles. Data from various sources were examined for potential application for enhancing the survivability of ground vehicles involved in fires.

Where potential payoffs in ground vehicle survivability were observed, a secondary objective was to make recommendations relative to enhancing that survivability.

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20. ABSTRACT (CONTINUED)

Damage repair costs, location, and causes of the fires were among the data examined. The largest contributing factor for the fires was human error; fuel leakage or spillage ranked second. Recommendations in the report emphasize the need for a review of fuel handling SOP's.

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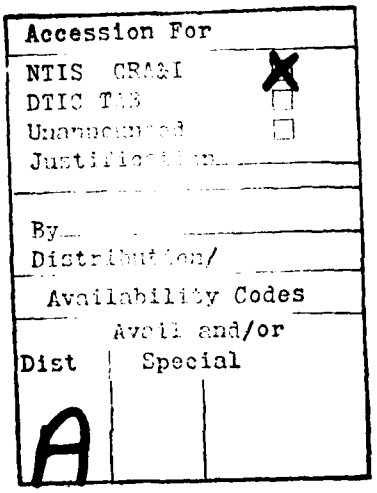
This report is the result of an effort initiated by Mr. Jim Lindenmuth, formerly of the Survivability Office, USAMSAA.



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NON-COMBAT FIRES IN ARMY GROUND VEHICLES

1. INTRODUCTION

1.1 Background.

Each year many military ground vehicles are damaged or destroyed by fire during normal peacetime operations. Reports on various fires are collected by the Office of the Chief of Engineers (OCE), and reports on accidents, whether they involve a fire or not, are collected by the Army Safety Center (ASC). Due to the sophisticated nature of some of the weapons systems involved, the financial and equipment loss can be significant. In a combat situation, the loss due to fire is expected to be far more severe, hence fire suppression and prevention techniques and equipment become vitally important to the survivability of a vehicle and its crew.

To determine methods of enhancing the survivability of Army ground vehicles involved in fires, the Survivability Office of the US Army Materiel Systems Analysis Activity (USAMSAA) initiated an in-house study of the available data on non-combat fires in those vehicles. This report presents the results of the in-house effort conducted by the Combat Support Division and the Ground Warfare Division for the Survivability Office.

1.2 Objective.

The primary objective of this effort was the investigation of the existing data related to non-combat fires in Army ground vehicles. These data (primarily from the OCE and the ASC) were examined for potential application for enhancing ground vehicle survivability. If there appeared to be potential payoffs in vehicle survivability, a secondary objective was to make recommendations relative to enhancing that survivability.

1.3 Scope.

This effort was limited to the available data from the OCE reports and the ASC computer printouts. The data from the OCE consisted of fire reports on Army ground vehicles involved in fires during the calendar years 1976 to 1979, inclusive. In accordance with AR 420-90, fire reports are to be submitted to the OCE when fire damage cost estimates exceed $300.00 (formerly $250.00). The data from the ASC consisted of reports on armored combat vehicles involved in fires which occurred from January 1976 to August 1978, inclusive. The data were analyzed; trends, if any, were determined; and factors contributing to the fires were identified. Where appropriate, recommendations were made relative to revising the fire report forms. Such revisions should yield data which would better identify factors contributing to the fires.

2. APPROACH

To achieve the objectives previously presented, the analysis was partitioned into the following four tasks.

2.1 Task 1 - Data Collection.

Review reports obtained from the OCE and the ASC and identify those related to fires in Army ground vehicles during the 1976-1979 time frame. Identify the data to be extracted from these reports for subsequent analysis.

2.2 Task 2 - Data Tabulation.

Organize and tabulate those data identified in Task 1 into a format suitable for trend evaluation.

2.3 Task 3 - Trend Evaluation.

Evaluate the data tabulated in Task 2 for the existence of trends. Indicate the adequacy of the supporting data.

2.4 Task 4 - Documentation.

Document overall effort and make recommendations relative to the reduction of vehicle vulnerability to fire damage and to improving the survivability of those vehicles involved in fires.

3. DATA

Data for this report came primarily from DA Forms 3985, which are reports on fires which have occurred on Army installations, or which involve Army materiel, where damage cost estimates exceed $300.00.

Copies of those reports involving vehicles were obtained from the OCE for the calendar years 1976-1979 inclusive, and numbered chronologically. Included in Appendix A is a copy of one of the fire reports (DA Form 3985) submitted to the OCE. The identification number assigned to each report for the purposes of this study is in the top right corner of the first page (7614 is the number assigned to the fire report shown in Appendix A). The first two digits of the identification number indicate the year during which the fire occurred. The last two digits indicate the chronological order of the fires within a specific year.

Where a fire report was overlooked in the initial numbering, letters were used to preserve the chronological sequence (for example, if an unnumbered report which belonged between 7612 and 7613 was found, 7612 was renumbered 7612A and the newly found report was numbered 7612B).

While the data from the OCE were being organized and tabulated, a limited amount of data from the Army Safety Center (ASC) was also available. These data were from reports of fires which occurred from January 1976 through August 1978 and involved tracked combat vehicles. A complete listing of vehicle fires which occurred from calendar 1976 to calendar 1979, inclusive, was requested from the ASC for possible future use.

In general, the OCE reports, being fire-oriented, were more helpful to this effort than the ASC reports. The ASC reports are structured to record data from accidents, fires, or any other incident which results in fatalities, property damage in excess of $300, and/or lost time beyond the day of the incident. Much of the information available from both sources is similar, but some differences are noted below.

The fire reports identified the causes of the fires more often than the accident reports and were more descriptive. They also provided more detail on the fire-fighting equipment, the procedures used in fighting the fires, and the vehicle's identification. Often the fire reports gave an itemized breakout of the major repair costs.

A list of the vehicles for which data were obtained appears in Appendix B. The fire incidents were categorized according to vehicle type, major cause, and the location of the origin of the fire.

The frequency and cost associated with each category is shown and then broken out by year in the various tables.

A listing of the various incidents (by identification number) in which each particular vehicle type was involved appears in Appendix C. Those reports unique to the ASC data source have an asterisk after the identification number.

Each vehicle type which had more than five fires during the 1976-1979 time frame was identified, if possible, by Army nomenclature. Those vehicle types which had fewer than five fires were all grouped together under the title "other."

The data were also classified by the primary cause for the fires. There are five "cause" categories: fuel; electrical; mechanical failure; human error; and unknown, arson, and other.

Some reports required a judgment when labeling the cause. For example, where an electrical short circuit ignited an accumulation of fuel and oil in an engine compartment, the severity of the resulting fire depended more on the accumulated fuel than on the electrical short which ignited it. Such a fire was classified as a "fuel" caused fire. If there had been no fuel present, and the electrical short ignited insulation and other materials normally present in the engine compartment, the fire would have been classified as an "electrical" type fire.

Fires for which the human element seemed to be primarily responsible were classified as "human error" type fires. Included within the "human error" category were fires caused by a soldier shooting a hole in a vehicle's fuel tank, storing ammunition too close to a vehicle's personnel-heater, removing vehicle components (such as mufflers, cooling system components, etc.) and not replacing them, and operating vehicles with obvious problems (engine overheating, transmission leaking and/or overheating, etc.).

Another manner in which the data were categorized was by the location of the fires' origins. Five different classifications were used: the engine compartment, the crew compartment (which includes the turret in applicable vehicles), the cargo area, other, and unknown.

In the process of gathering the vehicle related fire reports, a substantial number of electric generator set fires (22) was observed; these fires were considered as a side issue because the generator sets are powered by internal combustion engines and therefore have some characteristics in common with vehicles, e.g., fuel, oil, batteries, etc.

4. ANALYSIS

4.1 General Information.

This report is based on 204 fires involving tracked or wheeled vehicles and 22 fires involving electric generator sets. The fires occurred during the 1976-1979 time frame and resulted in approximately seven million dollars in damaged or destroyed materiel. There were 35 injuries and one fatality associated with these fires. Another 11 injuries were associated with two vehicles which overturned and caught fire; since the injuries were a result of the accidents rather than the fires, they were not included in this report.

Based on the available data, it was decided that only those vehicle types which were involved in more than five (5) fires should be considered for analysis.

4.2 Fires by Vehicle Type.

4.2.1 Frequency of Fires. Eight classes of vehicles accounted for 64.2 percent of all vehicle fires considered in this report. All the remaining vehicles were grouped into an "other" category. Two of the eight vehicle types, the M60/A1/A2 tanks (with 43 fires) and the M88 medium recovery vehicles (with 31 fires), accounted for 36.3 percent of the total number of vehicle fires.

The types of vehicles involved, the number of fires for each category, and the financial loss associated with each category of vehicle are summarized in Table 1 and broken out by year in Table 2.

TABLE 1 NUMBER AND COST OF FIRES BY VEHICLE TYPE - SUMMARY

Vehicle	Number of Fires	% of Total Number of Fires	Cost ($K)	% of Total Cost	Avg. Cost/ Fire ($K)
M60/A1/A2	43	21.1	1273.4	19.2	29.6
M88	31	15.2	1839.5	27.7	59.3
M551/A1	13	6.4	1809.9	27.2	139.2
M113/A1	11	5.4	400.0	6.0	36.4
M35A2	10	4.9	86.2	1.3	8.6
M151/A1/A2	10	4.9	30.0	0.5	3.0
M880/2/3	7	3.4	122.1	1.8	17.4
M561 (and M792)	6	2.9	54.9	0.8	9.2
Other	73	35.8	1027.6	15.5	14.1
Total	204	100.0	6643.6	100.0	32.6

TABLE 2 VEHICLE FIRES AND COSTS BY YEAR

Year Vehicle	(No. of Fires) 76 (Cost-$K)	(No. of Fires) 77 (Cost-$K)	(No. of Fires) 78 (Cost-$K)	(No. of Fires) 79 (Cost-$K)	(No. of Fires) Total (Cost-$K)
M60/A1/A2	16 600.2	11 230.0	11 300.1	5 143.1	43 1273.4
M88	8 810.4	9 560.8	12 397.5	2 70.8	31 1839.5
M551/A1	6 1078.2	5 541.4	2 190.3	- -	13 1809.9
M113/A1	5 120.3	5 278.9	1 0.8	- -	11 400.0
M35A2	1 3.1	5 51.2	2 3.4	2 28.5	10 86.2
M151/A1/A2	- -	3 10.3	3 8.8	4 10.9	10 30.0
M880/2/3	1 4.6	1 15.9	2 82.3	3 19.3	7 122.1
M561 (& 792)	2 25.7	1 15.3	- -	3 13.9	6 54.9
Other	15 54.0	27 286.9	21 433.2	10 253.5	75 1033.4
Total	54 2696.5	67 1990.7	54 1416.4	29 540.0	204 6643.6

4.2.2 Cost of Fires. The average cost per fire for each class of vehicles is shown in Table 1. Four types of vehicles have a substantially higher average cost per fire than the others. They are the M60/A1/A2, the M88, M551/A1 and the M113/A1.

A prominent factor in the high cost of the M551/A1 fires appears to be the combustible case ammunition used by the 152mm gun launcher weapon system. Information from the data source indicates that there is a problem with broken rounds resulting in propellant spillage.

Several of the M551/A1 fire reports indicated that the fires in the turrets flared up quickly and were uncontrollable within a few seconds of being discovered. These fires resulted in the crew abandoning the vehicles immediately, and the vehicles were heavily damaged or totally destroyed by the fires. Other fires in the turrets were far less serious, and resulted in a relatively minor amount of damage.

The sharp contrast in the rate at which these turret fires flared up indicates that some highly combustible material (perhaps propellant, or bits of the combustible case from the combustible case ammunition) was present in the turret and exposed to an ignition source in those cases in which the fires flared up so quickly.

Although the M60A2's have the same weapon system as the M551/A1's, the average cost per fire for the M60A2's is less than one percent of that of the M551/A1's. There were only three M60A2 fires, too few for forming any conclusions. It should be noted, though, that all three M60A2 fires were electrical in origin and occurred in the turret, as in the M551/A1 fires. It should also be noted that there were some turret fires in the M551/A1's which had relatively low repair cost estimates. Unfortunately there were no data in the fire reports which could suggest the reason for this drastic cost difference; perhaps no propellant spillage had occured, vehicles weren't loaded with ammunition,etc.

Four types of vehicles have a significantly higher total cost associated with them than the remaining types of vehicles. They are the M88, the M551/A1, the M60/A1/A2 and Other (see Table 1).

Although the M60/A1/A2's had the largest number of fires, both the M88's and the M551/A1's had costs which were about 150 percent as great as the M60/A1/A2 cost. The "Other" category had a relatively high cost associated with it primarily because it had almost twice as many fires (73) as the next largest group (43).

4.3 Fires by Cause

4.3.1 Frequency of Fires. Of the five classes of fire causes, the "human error" classification is, by far, the largest, with "fuel" second. There are 67 "human error" type fires, or 32.8 percent of all fires, and 53 fuel type fires, 26.0 percent of all fires. The number of fires attributed to each cause is shown in Table 3, along with its respec-

TABLE 3 NUMBER AND COST OF FIRES BY CAUSE-SUMMARY

Cause	No. of Fires	% of Total	Cost ($K)	% of Total
Human Error	67	32.8	1132.2	17.1
Fuel	53	26.0	1997.6	30.0
Electrical	32	15.7	1942.3	29.2
Mechanical Failure	31	15.2	401.5	6.1
Unknown, Arson, Other	21	10.3	1169.9	17.6
Total	204	100.0	6643.6	100.0

TABLE 4 NUMBER AND COST OF FIRES PER YEAR BY CAUSE

Cause \ Year	(No. of Fires) 76 (Cost-$K)	(No. of Fires) 77 (Cost-$K)	(No. of Fires) 78 (Cost-$K)	(No. of Fires) 79 (Cost-$K)	(No. of Fires) Total (Cost-$K)
Human Error	14 258.3	26 483.1	18 338.0	9 52.8	67 1132.2
Fuel	16 975.9	13 488.2	16 302.2	8 231.3	53 1997.6
Electrical	13 1112.6	10 586.4	6 24.7	3 218.6	32 1942.3
Mechanical Failure	6 47.9	10 107.5	8 219.6	7 26.6	31 401.6
Unknown, Arson, Other	5 301.8	8 325.5	6 531.9	2 10.7	21 1169.9
Total	54 2696.5	67 1990.7	54 1416.4	29 540.0	204 6643.6

tive percentage of the total number of fires. Table 4 gives a breakout of these figures by year.

Almost one-half of the fires caused by mechanical failures were due to personnel-heater failures. There were indications that the safety and reliability of these personnel heaters is highly questionable.

While there were a number of mechanical malfunctions of the personnel heaters, there were also human error problems associated with them. The dominant human error associated with the heaters seemed to be the tendency to place combustible materiel too close to them, resulting in a fire. A simple guard of some kind to keep materiel at a safe distance might significantly reduce the number of fires caused by this type of human error.

Of the seven fires caused by mechanical failure in the M88's, three were caused by the power take-off shaft coming loose. The rapidly rotating shaft severed fuel lines and caused fuel to be sprayed around the engine compartment, resulting in a fire.

4.3.2 Cost of Fires. The fuel and the electrical type fires were together responsible for over one-half of the cost of all fire damage. Fuel type fires accounted for 30.0 percent of the damage costs, while the electrical type fires were responsible for 29.2 percent of the costs. Fuel-leaks in the M60/A1's and the M88's were a major factor in the number and cost of fuel-caused fires. A major factor in the electrical type fires was the number of turret fires in the M551/A1's (see Tables 8 and 10).

4.4 Fires by Location.

4.4.1 Frequency of Fires. The locations of the origins of the vehicle fires were grouped into five categories: the engine compartment, the crew compartment (including the turret area in applicable vehicles), the cargo area, other, and unknown.

There were more than twice as many vehicle engine compartment fires as there were in any other category. Crew compartment fires and cargo area fires were second and third, respectively. The summary is shown in Table 5 and broken out by year in Table 6.

4.4.2 Cost of Fires. The engine compartment fires, crew compartment fires, and cargo area fires accounted for over 80 percent of all fires, and over 90 percent of the costs associated with the fires. The summary is shown in Table 5 and broken out by year in Table 6.

4.5 Causes by Vehicle Type.

There were 3 classes of vehicles in which there was a dominant "cause" for the fires, that is, a cause which was responsible for a substantial percentage of the fires in a particular type of vehicle.

TABLE 5 NUMBER AND COST OF FIRES BY LOCATION WITHIN VEHICLE

Location	Number of Fires	% of Total Number of Fires	Cost ($K)	% of Total Cost	Avg. Cost per Fire($K)
Engine Compartment	100	49.0	3227.4	48.6	32.3
Crew Compartment	47	23.0	2334.0	35.1	49.7
Cargo Area	34	16.7	648.5	9.7	19.1
Other	15	7.4	183.7	2.8	12.2
Unknown	8	3.9	250.0	3.8	31.3
Total	204	100.0	6643.6	100.0	32.6

TABLE 6 NUMBER AND COST OF FIRES PER YEAR BY LOCATION WITHIN VEHICLE

Year / Location	(No. of Fires) 76 (Cost-$K)	(No. of Fires) 77 (Cost-$)	(No. of Fires) 78 (Cost-$K)	(No. of Fires) 79 (Cost-$K)	(No. of Fires) Total (Cost-$K)
Engine Compartment	30 1406.0	29 746.3	34 891.8	7 183.3	100 3227.4
Crew Compartment	10 1109.9	18 860.1	9 275.0	10 89.0	47 2334.0
Cargo Area	4 33.7	13 118.8	7 229.5	10 266.5	34 648.5
Other	7 132.4	5 46.9	1 3.2	2 1.2	15 183.7
Unknown	3 14.5	2 218.6	3 16.9	- -	8 250.0
Total	54 2696.5	67 1990.7	54 1416.4	29 540.0	204 6643.6

The vehicle type, the percentage of that vehicle type's fires charged to the cause listed, and the percentage of the costs associated with that vehicle type for which the cause listed is responsible are presented in Table 7. For the complete summary concerning other vehicle types, refer to Table 8. The information is broken out by year in Table 9.

The M60A2's are grouped with the M551/A1's in Tables 7-10, inclusive, because both vehicle types have a common main weapon system, the 152mm gun/launcher. The fire control system, with its sophisticated electronics, has a history of short circuits and other electrical problems. The sparks which result from a short circuit provide an ignition source for combustible materials, thereby increasing the probability of a fire.

TABLE 7 PRIMARY VEHICLES AND DOMINANT CAUSES OF FIRE

Vehicle	Cause	Percent of Fires Based on the No. of Fires for the Particular Vehicle	Percent of Cost Based on the Cost Associated With the Particular Vehicle
M60/A1	Fuel	37.5	30.6
M88	Fuel	45.2	70.3
M551/A1, M60A2	Electrical	68.7	88.4

"Poor housekeeping" (i.e., allowing leaves and other combustibles to accumulate in the vehicle) and oil or fuel leaks appear to be major factors in M60 and M88 series vehicle fires.

Eight of the thirteen M551/A1 fires were initiated by electrical problems in the turret area. Due to the rapid propagation of most of these fires, it is probable that the electrical shorts were only the ignition source for some other "cause," possibly propellant from the combustible case ammunition on the turret floor or possibly an accumulation of oil and/or fuel under the turret floor.

The individual fire damage cost estimates for the M551/A1's varied greatly. Five of the previously mentioned eight "electrical" fires resulted in over $230K damage per vehicle. In contrast, two of the M551/A1 "electrical" fires and all three of the M60A2 "electrical" fires resulted in less than $2K damage per vehicle. The remaining M551/A1 "electrical" fire damage cost estimate was $10.9K.

TABLE 8 NUMBER AND COST OF FIRES BY VEHICLE AND CAUSE-SUMMARY

Vehicle	Cause	No. of Fires	% Based on the Total # of Fires for the Vehicle Listed	Cost ($K)	% Based on the Total Cost Associated With the Vehicle Listed
M60/A1	Human Error	7	17.5	156.9	12.4
	Fuel	15	37.5	389.2	30.6
	Electrical	8	20.0	81.4	6.4
	Mechanical Failure	3	7.5	72.6	5.7
	Unknown, Arson, Other	7	17.5	570.8	44.9
	Total	40	100.0	1270.9	100.0
M88	Human Error	7	22.6	113.2	6.2
	Fuel	14	45.2	1293.6	70.3
	Electrical	1	3.2	0.8	-
	Mechanical Failure	7	22.6	230.8	12.6
	Unknown, Arson, Other	2	6.4	201.1	10.9
	Total	31	100.0	1839.5	100.0
*M551/A1 & M60A2	Human Error	2	12.4	39.5	2.2
	Fuel	1	6.3	18.0	1.0
	Electrical	11	68.7	1600.9	88.4
	Mechanical Failure	1	6.3	2.7	0.1
	Unknown, Arson, Other	1	6.3	151.3	8.3
	Total	16	100.0	1812.4	100.0

* The M60A2's were grouped with the M551/A1's here because the two vehicles have a common major weapon system. The fire control for the main weapon system is thought to be responsible for a large percentage of the short circuits occurring in the turret area.

TABLE 8 NUMBER AND COST OF FIRES BY VEHICLE AND CAUSE-SUMMARY (CONT'D)

Vehicle	Cause	No. of Fires	% Based on the Total # of Fires for the Vehicle Listed	Cost ($K)	% Based on the Total Cost Associated With the Vehicle Listed
M113/A1	Human Error	5	45.4	288.3	72.1
	Fuel	2	18.2	104.4	26.1
	Electrical	2	18.2	5.8	1.4
	Mechanical Failure	1	9.1	0.7	0.2
	Unknown, Arson, Other	1	9.1	0.8	0.2
	Total	11	100.0	400.0	100.0
M35A2	Human Error	3	30.0	26.8	31.1
	Fuel	4	40.0	47.6	55.2
	Electrical	-	-	-	-
	Mechanical Failure	2	20.0	11.4	13.2
	Unknown, Arson, Other	1	10.0	0.4	0.5
	Total	10	100.0	86.2	100.0
M151/A1/A2	Human Error	4	40.0	13.4	44.7
	Fuel	-	-	-	-
	Electrical	-	-	-	-
	Mechanical Failure	5	50.0	16.2	54.0
	Unknown, Arson, Other	1	10.0	0.4	1.3
	Total	10	100.0	30.0	100.0
M880/2/3	Human Error	5	71.4	31.4	25.7
	Fuel	-	-	-	-
	Electrical	-	-	-	-
	Mechanical Failure	1	14.3	9.0	7.4
	Unknown, Arson, Other	1	14.3	81.7	66.9
	Total	7	100.0	122.1	100.0

TABLE 8 NUMRER AND COST OF FIRES BY VEHICLE AND CAUSE-SUMMARY (CONT'D)

Vehicle	Cause	No. of Fires	% Based on the Total # of Fires for the Vehicle Listed	Cost ($K)	% Based on the Total Cost Associated With the Vehicle Listed
M561 and M792	Human Error	3	50.0	39.4	71.8
	Fuel	-	-	-	-
	Electrical	1	16.7	8.3	15.1
	Mechanical Failure	1	16.7	1.2	2.2
	Unknown, Arson, Other	1	16.7	6.0	10.9
	Total	6	100.0	54.9	100.0
Other	Human Error	31	42.5	423.3	41.2
	Fuel	17	23.3	144.8	14.1
	Electrical	9	12.3	245.1	23.9
	Mechanical Failure	10	13.7	57.0	5.5
	Unknown, Arson, Other	6	8.2	157.4	15.3
	Total	73	100.0	1027.6	100.0

TABLE 9 NUMBER AND COST OF FIRES BY VEHICLE, CAUSE, AND YEAR

Vehicle	Cause	(No. of Fires) 76 (Cost-$K)	(No. of Fires) 77 (Cost-$K)	(No. of Fires) 78 (Cost-$K)	(No. of Fires) 79 (Cost-$K)	(No. of Fires) Total (Cost-$K)
M60/A1	Human Error	2 79.6	1 20.9	2 24.8	2 31.6	7 156.9
	Fuel	7 192.9	- -	6 85.3	2 111.0	15 389.2
	Electrical	3 21.3	3 51.6	2 8.5	- -	8 81.4
	Mechanical Failure	1 17.4	2 55.2	- -	- -	3 72.6
	Unknown, Arson, Other	3 289.0	3 100.3	1 181.5	- -	7 570.8
	Total	16 600.2	9 228.0	11 300.1	4 142.6	40 1270.9
M88	Human Error	2 17.7	3 76.7	2 18.8	- -	7 113.2
	Fuel	4 769.3	3 267.6	5 185.9	2 70.8	14 1293.6
	Electrical	- -	- -	1 0.8	- -	1 0.8
	Mechanical Failure	2 23.4	1 15.4	4 192.0	- -	7 230.8
	Unknown, Arson, Other	- -	2 201.1	- -	- -	2 201.1
	Total	8 810.4	9 560.8	12 397.5	2 70.8	31 1839.5

TABLE 9 NUMBER AND COST OF FIRES BY VEHICLE, CAUSE, AND YEAR (CONT'D)

Vehicle	Cause	(No. of Fires) 76 (Cost-$K)	(No. of Fires) 77 (Cost-$K)	(No. of Fires) 78 (Cost-$K)	(No. of Fires) 79 (Cost-$K)	(No. of Fires) Total (Cost-$K)
M551/A1 and M60A2	Human Error	-	1	1	-	2
		-	0.5	39.0	-	39.5
	Fuel	-	1	-	-	1
		-	18.0	-	-	18.0
	Electrical	5	5	-	1	11
		1075.5	524.9	-	0.5	1600.9
	Mechanical Failure	1	-	-	-	1
		2.7	-	-	-	2.7
	Unknown, Arson, Other	-	-	1	-	1
		-	-	151.3	-	153.3
	Total	6	7	2	1	16
		1078.2	543.4	190.3	0.5	1812.4
M113/A1	Human Error	2	3	-	-	5
		108.5	179.8	-	-	288.3
	Fuel	1	1	-	-	2
		6.0	98.4	-	-	104.4
	Electrical	2	-		-	2
		5.8	-	-	-	5.8
	Mechanical Failure	-	1	-	-	1
		-	0.7	-	-	0.7
	Unknown, Arson, Other	-	-	1	-	1
		-	-	0.8	-	0.8
	Total	5	5	1	-	11
		120.3	278.9	0.8	-	400.0

TABLE 9 NUMBER AND COST OF FIRES BY VEHICLE, CAUSE, AND YEAR (CONT'D)

Vehicle	Cause	(No. of Fires) 76 (Cost-$K)	(No. of Fires) 77 (Cost-$K)	(No. of Fires) 78 (Cost-$K)	(No. of Fires) 79 (Cost-$K)	(No. of Fires) Total (Cost-$K)
M35A2	Human Error	-	3	-	-	3
		-	26.8	-	-	26.8
	Fuel	1	1	-	2	4
		3.1	16.0	-	28.5	47.6
	Electrical	-	-	-	-	-
		-	-	-	-	-
	Mechanical Failure	-	1	1	-	2
		-	8.4	3.0	-	11.4
	Unknown, Arson, Other	-	-	1	-	1
		-	-	0.4	-	0.4
	Total	1	5	2	2	10
		3.1	51.2	3.4	28.5	86.2
M151/A1/A2	Human Error	-	2	1	1	4
		-	9.9	3.2	0.3	13.4
	Fuel	-	-	-	-	-
		-	-	-	-	-
	Electrical	-	-	-	-	-
		-	-	-	-	-
	Mechanical Failure	-	-	2	3	5
		-	-	5.6	10.6	16.2
	Unknown, Arson, Other	-	1	-	-	1
		-	0.4	-	-	0.4
	Total	-	3	3	4	10
		-	10.3	8.8	10.9	30.0

TABLE 9 NUMBER AND COST OF FIRES BY VEHICLE, CAUSE, AND YEAR (CONT'D)

Vehicle	Cause	(No. of Fires) 76 (Cost-$K)	(No. of Fires) 77 (Cost-$K)	(No. of Fires) 78 (Cost-$K)	(No. of Fires) 79 (Cost-$K)	(No. of Fires) Total (Cost-$K)
M880/2/3	Human Error	1 4.6	1 15.9	1 0.6	2 10.3	5 31.4
	Fuel	- -	- -	- -	- -	- -
	Electircal	- -	- -	- -	- -	- -
	Mechanical Failure	- -	- -	- -	1 9.0	1 9.0
	Unknown, Arson, Other	- -	- -	1 81.7	- -	1 81.7
	Total	1 4.6	1 15.9	2 82.3	3 19.3	7 122.1
M561 (and M792)	Human Error	1 17.4	1 15.3	- -	1 6.7	3 39.4
	Fuel	- -	- -	- -	- -	- -
	Electrical	1 8.3	- -	- -	- -	1 8.3
	Mechanical Failure	- -	- -	- -	1 1.2	1 1.2
	Unknown, Arson, Other	- -	- -	- -	1 6.0	1 6.0
	Total	2 25.7	1 15.3	- -	3 13.9	6 54.9

TABLE 9 NUMBER AND COST OF FIRES BY VEHICLE, CAUSE, AND YEAR (CONT'D)

Vehicle	Cause	(No. of Fires) 76 (Cost-$K)	(No. of Fires) 77 (Cost-$K)	(No. of Fires) 78 (Cost-$K)	(No. of Fires) 79 (Cost-$K)	(No. of Fires) Total (Cost-$K)
Other	Human Error	6 30.5	11 137.3	11 251.6	3 3.9	32 427.2
	Fuel	3 4.6	7 88.2	5 31.0	2 21.0	17 144.8
	Electrical	2 1.7	2 9.9	3 15.4	2 218.1	9 245.1
	Mechanical Failure	2 4.4	5 27.8	1 19.0	2 5.8	11 58.9
	Unknown, Arson, Other	2 12.8	2 23.7	1 116.2	1 4.7	6 157.4
	Total	15 54.0	27 286.9	21 433.2	10 253.5	73 1027.6

4.6 Location by Vehicle Type.

The cost and number of fires by location within a particular type of vehicle is shown in Table 10.

About 87 percent of the M60/A1 and M88 fires started in the engine compartment; these were closely related to the large percentage of fuel caused fires.

Over 87 percent of the M551/A1 and M60A2 fires originated in the turret area. Most of these fires were the result of sparks from electrical short circuits. The electrically operated turret of the M551/A1 and the missile fire control system in both vehicles make the turret area of these vehicles particularly susceptible to electrically initiated fires.

It should be noted that the fires which occurred in the wheeled, cargo vehicles (M35A2, M880/2/3) originated almost exclusively in the cargo area of the vehicles and involved the cargo rather than a vehicle subsystem.

4.7 Vehicles With Fixed Fire Extinguishing Systems (FFES).

There were no data available pertaining to fires which caused less than $300 in damaged materiel, and the available data were inadequate for determining the effectiveness of the FFES in suppressing the fires (as opposed to extinguishing them). There were, however, comments in some of the fire reports indicating that the FFES did contribute toward control or suppression of the fires. Due to cost procedure (i.e., $300 limit), data are not available which indicate the effectiveness of the FFES for the low or no damage situations. This lack of data could be very misleading to someone intersted in FFES effectiveness.

Of the fires addressed in this report, 114 involved vehicles which had FFES. There was one vehicle for which it could not be determined whether or not the vehicle had an FFES. In 69 of these 114 incidents (60.5 percent), attempts were made to extinguish the fires by means of the FFES. Table 11 presents the number of attempts to use the FFES, the number of times the FFES actually discharged, and the number of extinguishments achieved by them.

It also provides a breakout of engine compartment fires versus fires in all other locations. The FFES are located in the engine compartments of applicable vehicles (M60/A1/A2's, M88's, M113/A1's, and M551/A1's). The percentage of attempts to use the FFES for engine compartment fires was far greater than for fires in other locations, 70.3 percent versus 42.5 percent (see Table 12). The percentage of extinguishments given that the FFES was used, however, is essentially the same for both categories, 17.3 percent for engine compartment fires versus 17.6 percent for fires in other locations. Based on these findings the FFES in a

TABLE 10 LOCATION OF IGNITION POINT OF FIRE BY VEHICLE TYPE

Vehicle	(No. of Fires) Crew Compartment (Cost-$K)	(No. of Fires) Engine Compartment (Cost-$K)	(No. of Fires) Cargo Area (Cost-$K)	(No. of Fires) Other (Cost-$K)	(No. of Fires) Unknown (Cost-$K)	(No. of Fires) Total (Cost-$K)
M60/A1	5 78.6	33 1191.0	- -	2 1.3	- -	40 1270.9
M88	1 60.0	29 1579.6	- -	- -	1 199.9	31 1839.5
M60A2 and M551/A1	14 1791.7	2 20.7	- -	- -	- -	16 1812.4
M113/A1	7 272.9	3 18.9	- -	1 108.2	- -	11 400.0
M35A2	- -	2 11.4	7 74.4	- -	1 0.4	10 86.2
M151/A1/A2	6 16.6	- -	- -	4 13.4	- -	10 30.0
M880/2/3	1 9.0	- -	6 113.1	- -	- -	7 122.1
M561(792)	2 9.5	- -	3 28.0	1 17.4	- -	6 54.9
Other	11 95.7	31 405.8	18 433.0	7 43.4	6 49.7	75 1033.4
Total	47 2334.0	100 3227.4	34 648.5	15 183.7	8 250.0	204 6643.6

TABLE 11 USE OF FIXED FIRE EXTINGUISHING SYSTEMS (FFES)

I.	Number of Vehicles Which had FFES	114
	Unknown	1
II.	Number of Engine Compartment Fires	74
	Number of Fires in Other Locations	40

		Fire Location		
		Engine Compartment	Other Locations	Total
III.	Number of Attempts to Use the FFES	52	17	69
	Number of Times FFES Were not Used	8	13	21
	Unknown	14	10	24
IV.	Number of Times FFES Discharged	38	13	51
	Number of Times FFES did not Discharge	13	3	16
	Unknown	1	1	2
V.	Number of Fires Extinguished by FFES	9	3	12
	Number of Fires not Extinguished by FFES	29	10	39
	Unknown	-	-	-

TABLE 12 FFES RELATED PERCENTAGES

	Engine Compartment	Other Locations	Total
Percentage of Number of Attempts to Use the FFES Relative to the Number of Fires	70.3	42.5	60.5
Percentage of Number of Times the FFES Discharged Relative to the Number of Attempts to Use the FFES	73.1	76.5	73.9
Percentage of Number of Extinguishments Relative to the Number of Times the FFES Discharged	23.7	23.1	23.5
Percentage of Number of Extinguishments Relative to the Number of Attempts to Use the FFES	17.3	17.6	17.4
Percentage of Number of Extinguishments Relative the Number of Fires	12.2	7.5	10.5

vehicle should be activated in the event of any internal fire which cannot be quickly controlled by other available means (such as portable extinguishers,etc.). Extinguishments in locations other than the engine compartment are probably due to the extinguishing agent (CO_2) having access to the crew compartment (in the M60's, the M88's, the M113's, and the M551's) by means of an opening in the bottom of the bulkhead between the engine and the crew compartments. Another possibility is that an engine compartment fire spread through the opening in the bulkhead and was mislabeled as a crew compartment fire and use of the FFES did, in actuality, put out the fire at its origin.

It should be noted that, according to the available data, the FFES failed to discharge in approximately 25 percent of the attempts to use them. This malfunctioning of the FFES appears to be a significant problem; however, the available data were inadequate for a detailed investigation of the problem.

4.8 Electric Generator Set Fire Summary.

The generator set fires were placed in a category of their own. Most of the generator sets were either skid or trailer mounted, and in most of the generator set incidents, they were being hauled or towed by trucks. Therefore, these incidents would probably fall most naturally into the "cargo area" location category. They were treated as a separate category because there were a significant number of them.

Almost all of the generator set fires were caused by human error. Where the fires occurred during transport, the fuel was usually being transported with the generator, although comments from the data source indicated that Army regulations require that fuel be separated from the generators during transport.

Fuel vapors from spills or from leaking fuel storage containers created potentially dangerous conditions. Vapors were often ignited by something falling across or against the battery posts, causing a short circuit; the resulting sparks caused the fuel vapors to ignite. Proper inspections would probably have revealed spills and leaking fuel containers, as well as damaged or missing insulation covers which should have protected the battery posts from short circuiting.

A closely related problem is that many of the fuel storage containers were improperly secured. In many cases, these improperly secured containers fell over and leaked. Some fell against the batteries, short circuiting the posts. Improperly secured fuel containers, then, were partly responsible for causing the fuel spills and leaks.

During the 1976-1979 timeframe there were twenty-two electric generator set fires which cost the Army $252.9K (3.7 percent of the total cost). Human error was the dominant cause; 91 percent of the total number of fires were attributable to it. Human error was responsible for 93.1 percent of the total fire damage cost for electric generator sets.

5. COMMENTS ON DA FORM 3985 (OCE FIRE REPORTS)

Enclosed in Appendix A is a copy of one of the fire reports submitted to the OCE. Those reports which were conscientiously filled out and submitted to the OCE made this analysis possible. Where the data collectors were unable to determine (1) the cause of a fire and/or (2) other critical data, the results of an analysis of that particular fire incident is questionable.

Further analyses of this type would be greatly aided if the following suggestions were observed in filling out DA Form 3985, particularly when vehicles are involved.

(1) In Section 4, state the location of the fire within the vehicle, e.g., engine compartment, cab, etc.

(2) In Section 5, supply the name and duty position, e.g., tank commander, driver, guard, bystander, etc.

(3) In Section 8, state precise vehicle identification number

(4) In Section 9, state specific vehicle nomenclature, e.g., M60A1 tank, M35A2 2 1/2 ton cargo truck, etc.

(5) In Section 29, the requested data are essential to any analysis concerned with determining the causes of fires in Army ground vehicles; be as specific as possible, e.g., leak in fuel injector line, electrical short in turret slip ring, etc.

(6) In Section 31, the date of the last inspection should be listed, along with the inspector, e.g., tank commander, driver, maintenance personnel, etc.

(7) In Section 32, provide a detailed account of the incident. The following data should be provided:

(a) Date and time of fire

(b) Geographical location, e.g., street name, range number, etc.

(c) Description of circumstances and conditions pertaining to the fire

(d)
- Did the vehicle have an FFES?
- If so, was it used?
- If so, did it discharge properly?
- If so, did it extinguish the fire?

(e) Who extinguished the fire? By what means?

(f) Were there any known malfunctions of the vehicle which may have contributed to the fire? e.g., fuel return line leaking, electrical short in wiring harness, transmission overheating, etc.

(g) Estimated damage cost showing major parts and labor cost for repair

(h) What could have been done to prevent this particular fire?

(i) Was the vehicle combat loaded? If so, did the load contribute to the cause or extent of the fire?

(j) What would it cost to replace this vehicle if it is considered a total loss?

(k) Any other information which would be helpful in determining the causes of vehicle fires and/or which would enhance the survivability of Army ground vehicles involved in fires or which might help prevent fires in these vehicles.

6. OBSERVATIONS AND CONCLUSIONS

In view of the amount of equipment used by the US Army, the number of fires reported to the OCE annually seems fairly low. However, not all applicable fires (those resulting in $300 or more in damage costs) were reported to the OCE in the 1976-1979 time frame. Over 10 percent of the vehicle fires considered in this report were reported to the ASC, but not to the OCE. While the number of fires seemed fairly low, some specific problem areas were emphasized by analysis of the available data.

Accumulated debris of a combustible nature contributes to the probability and severity of a fire occurring in a vehicle. Armored vehicles are more prone to accumulate debris in the engine compartment because of the protective armor under the engine. This floor traps materials, some of which are such combustibles as fuel, oil, leaves, etc., which in other vehicles would simply fall to the ground. Accumulations of debris were evident in several of the systems considered in this report.

Fuel leaks were a major factor in nearly half of the engine compartment fires which occurred in the M60/A1's and the M88's.

Due to the engine being fully enclosed, electrical shorts, fuel leaks, and other problems in the engine compartments, depending on their location, may be difficult or impossible to detect during a routine inspection of an armored vehicle.

Poor maintenance practices also contributed to the fire problem. There were cases, for example, where cooling system components were not replaced on M60/A1 tanks, and where, apparently, bolts and/or nuts had not been properly replaced or tightened on the power take-off shafts on the M88 recovery vehicles. Where these power take-off shafts came loose, they ruptured fuel lines, flinging fuel all over the engine. The resulting fires were probably ignited by the hot engine, or by sparks caused by the rapidly rotating power take-off shaft striking other engine parts.

For those situations where fires resulted in $300 or more in vehicle damages, the fixed fire extinguishing systems (FFES) on applicable vehicles extinguished less than 18 percent of the fires on which they were used. Some of the users indicated that the FFES significantly suppressed or controlled the fires, but it is not clear to what extent they may have helped in this regard. It appears that the FFES can extinguish fires before they reach a certain severity; after that, they only aid in temporarily controlling or suppressing the fires. One factor contributing to the severity of the engine compartment fires is that they are usually well advanced before discovery.

Due to the possibility of propellent spillage from damaged combustible case ammunition in the turret of the M551/A1's, fires and/or sparks in the turret area of these vehicles are extremely dangerous.

Historically, the M551/A1's have had a lot of electrical problems in the turret area due to the electrically-operated turret and the missile fire control system. It is not unusual for these electrical problems to cause sparks, thereby providing an ignition source for any propellent or other combustible material accumulated nearby.

As indicated earlier, nearly one half of the fires caused by mechanical failures were due to personnel heater malfunctions. There appears to be a potential fire hazard related to the usage of these vehicle personnel heaters in their present configuration.

Fires in the electric generator sets were due almost exclusively to human errors. Fuel storage containers apparently were not checked for leaks, some of the containers had no gaskets, containers were improperly secured for transport, fuel was spilled while re-fueling the generator sets, fuel was not separated from the generator sets during transport, and apparently the protective covers which go over the battery/cable connections to prevent short-circuiting were discarded or not properly installed. Fuel vapors from spilled/leaking fuel, ignited by sparks from a short-circuited battery post, were a major factor in the generator set fires. Perhaps relocation of the battery and a proper fuel storage location on the generator could significantly decrease the opportunities for the human errors.

7. RECOMMENDATIONS

- Review SOP with respect to fuel and combustible material clean-up procedures in ground vehicle systems. Emphasize fire hazards due to the accumulation of these materials in vehicles.

- Review SOP with regard to care, handling, and firing of 152mm combustible case ammunition. Emphasize fire hazards associated with broken rounds and the combustible case itself.

- In situations which demand the operation of vehicles with known mechanical or electrical malfunctions, potential fire hazards should be recognized and precautions taken to minimize chance of, and/or severity of, fire. For example, expedient fixes (like taping of exposed wires which are causing short circuits, etc.) should be applied to known malfunctions before attempting to operate these vehicles, and they should be accompanied by sufficient equipment to quickly extinguish any fires which may occur.

- Vehicles which have FFES should discharge them in the event of any interior fire, and not just for engine compartment fires.

- Fire sensors should be installed in the engine compartments of armored vehicles, since early awareness of a fire is crucial to its rapid extinguishment. Timely use of FFES would probably extinguish fires in their early stages.

- Install a guard on or around personnel heaters to keep combustible materials at a safe distance.

- Consideration should be given to re-routing fuel lines which are located near potentially hazardous power take-off shafts on M88 series vehicles.

- The necessity of safe fuel handling practices should be emphasized when working with electric generator sets. Since most of the problems involved the improper storage of fuel with the generator sets, perhaps a properly designed fuel storage container/mount on the generator set would be appropriate.

- Physically separating the fuel (and potential spillage) and the battery could lessen the hazard if protective covers are not used/ maintained on the battery/cable connection on electric generators; this also applies to vehicles.

AUTHORS' FINAL COMMENTS

As they exist today, the reporting process and resulting data base are not adequate for a thorough fire analysis. Data would be needed from the fires which resulted in less than $300 in damage costs, and, as indicated in the comments (Section 5) pertaining to DA Form 3985 (fire reports), more detail is required.

Conclusions or trends over time (1976-1980) could not be obtained as originally desired due to the lack of specific vehicle identification, details on specific vehicle updates, and records of maintenance/mileage.

If more data, as previously suggested, are included in future fire reports an annual or biannual analysis similar to this effort may reveal emerging fire problem areas.

APPENDIX A

SAMPLE OF A FIRE REPORT (DA FORM 3985)

Next page is blank.

Enclosed in Appendix A is a copy of one of the fire reports (DA Form 3985) submitted to the office of the Chief of Engineers (OCE).

In this particular report, Section 32, entitled "Describe Occurrence," is filled out in detail, acquainting the reader with the circumstances surrounding the fire, and providing the parts and labor costs associated with repairing the vehicle.

This fire report was more complete than many which were submitted to the OCE.

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FIRE REPORT

For use of this form, see AR 95-22; the proponent agency is the Office of the Chief of Engineers

REPORTS CONTROL SYMBOL

1. POST Fort Hood, Texas	2. DATE OF FIRE 14 Jun 76	3. TIME 1035 A.M.	4. EXACT LOCATION OF FIRE Engine compartment
5. REPORTED BY [redacted]	6. METHOD OF NOTIFICATION Range Control hot line		7. DATE AND TIME FIRE OUT 14 Jun 76 [illegible]

8. BUILDING NO.	9. KIND OF BUILDING	10. NUMBER OF STORIES	11. DIMENSIONS (Feet)	12. CONSTRUCTION (Type of materials) (a) WALLS	(b) FLOOR	(c) ROOF	(d) [illegible]
NA	NA	NA	NA WIDTH NA LENGTH	NA	NA	NA	NA

13. OCCUPANCY	14. DESCRIPTION OF DAMAGE TO— (a) BUILDING	(b) CONTENTS
NA	NA	NA

15. OTHER PROPERTY DAMAGED
M-88 Recovery Vehicle 9B5811

16. CASUALTIES (Number) (a) INJURIES: NA (b) DEATHS: NA

	17. MAKE OF HEAD	18. SYSTEM (Check) WET	DRY	19. NUMBER OF HEADS OPENED	20. OPERATION (Check one)	21. PROTECTION RESTORED
AUTOMATIC SPRINKLERS	NA	NA	NA	NA	☐ SATISFACTORY ☐ UNSATISFACTORY NA	DATE ____ TIME NA

	22. NAME AND TYPE OF SYSTEM	23. ALARM (Check) (a) CONNECTED TO FIRE DEPARTMENT	(b) LOCAL	24. OPERATION (Check one)
AUTOMATIC FIRE ALARM	NA	NA	NA	☐ SATISFACTORY ☐ UNSATISFACTORY NA

	25. HOSE STREAMS (Number, size, length of hose lines, and diameter of nozzles)	26. FIRE EXTINGUISHERS (Number, type, and size)
EQUIPMENT USED TO EXTINGUISH FIRE	1-150' 1" booster line; 1-50' 1½" line	Two 5# CO^2

27. MOTORIZED FIRE APPARATUS RESPONDING (a) NUMBER	(b) CLASS	(c) USA REGISTRATION NO.	28. FIRE DEPT. PERSONNEL RESPONDING (a) NUMBER CIVILIAN	(b) NUMBER MILITARY
1	1000-gal tnkr	USA 05A23271	7	0

29. CAUSE	30. FACTORS CONTRIBUTING TO EXTENT OF DAMAGE	31. PREVIOUS INSPECTION (a) DATE	(b) BY
Fuel leak ignited by electrical short	Faulty wiring	NA	NA

32. DESCRIBE OCCURRENCE (Use additional sheets, if necessary) THIS IS A FINAL FIRE REPORT.

At 1035 hours, 14 June 1976, E6 [redacted] from G3 Range Section, reported a fire in one M-88 tank recovery vehicle, USA #9B5811, serial #300. The vehicle belongs to HHC, 2/66th Armor, 2d Armored Division; CPT [redacted] is the commander. The Fire Department responded with a 1000-gallon tanker, USA #05A23271, and one 500# powder truck, USA #0ID42466. Fire was extinguished with 900 gallons of water and 5 gallons of light water. Cause of fire was an overheated transmission. SP4 [redacted], HHC, 2/66th Armor, 2d Armored Division, driver of the vehicle, stated that he was en route from North Fort Hood to South Fort Hood on the tank trail paralleling South Range Road just north of Rod and Gun Club when fire occurred. This vehicle had been having heating problems with transmission and, about three weeks ago, a new transmission had been installed; however, heating problems still existed. SP4 [redacted] said they had stopped twice before to let transmission cool. This time the temperature gauge started acting up and jumped to 320°. He started slowing down and E2 [redacted] the assistant driver, said he started out the top hatch, saw the fire, and told [redacted] to stop. [redacted] stated he stopped and tried to initiate the fixed fire extinguishers but they didn't work. They dismounted and tried to initiate the fire extinguishers from outside but they still didn't work. They tried two 5# CO^2 extinguishers but they did no good.

Final Fire Report No. FY 76-35

33. ARMY AMOUNT OF LOSS (a) BUILDING	(b) CONTENTS	(c) OTHER	(d) TOTAL	34. NON-ARMY
$	$	$ 2.00	$ 2.00	$

35. SUBMITTED BY
JOHN G. DRISKILL, COL, GS
Facility Engineer
17 June 1976 (Date)

36. APPROVED BY
G. P. MATTESON, COL, Armor
Deputy Installation Commander
(Date)

DA FORM 3985 REPLACES DA FORM 9-2, 1 OCT 64, WHICH WILL BE USED.

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[redacted] stated the motor sergeant, E7 [redacted] knew about the transmission problem and told him to drive it back but watch it and take it easy. Sergeant [redacted] stated he sent a jeep to follow the tank back and if they had any problems to stop and send the jeep back to the motor pool and get him so he could go out to check the problem.

Probable cause: Fuel leak
Reason for cause: Defective electrical wiring and cannon plug causing electrical short and ignited leaking fuel
Responsible person: CPT [redacted]
Amount of loss: $5,542.00
Regulation violated: Chapter 5, Para 5-2b(4), (5), & (7), III Corps and Fort Hood Reg 420-1
Supporting evidence: Statements of SP4 [redacted] and E2 [redacted], DIC report
Action necessary to prevent fires from similar causes: Review and compliance by company commanders with Chapter 5, III Corps and Fort Hood Reg 420-1, and applicable TMs on maintenance of tactical vehicles.
Disciplinary action: None
Liability: Recommend that person and/or persons responsible reimburse the Government for all damages if negligence is found

7K

EQUIPMENT MALFUNCTION/FAILURE REPORT

1. UNIT OR BATTERY

2/66th Armor, 2d AD

2. TYPE EQUIPMENT

Recovery Vehicle M88

SERIAL NUMBER	TUBE NUMBER	BREECH RING NUMBER
300		

MODEL NUMBER	MANUFACTURER'S NAME	USA NUMBER
		98 5811

3. TYPE OF MALFUNCTION/FAILURE

Fire in Engine Compartment

4. NUMBER AND TYPE OF INJURIES TO PERSONNEL

None

5. OTHER INFORMATION CONSIDERED IMPORTANT AND PERTINENT

a. Items damaged:

(1) 2 ea engine cylinders

(2) 3 ea oil coolers

(3) 1 ea cooling fan assy

(4) 1 ea engine wiring harness R/bank--ignition

(5) All fuel line right bank

(6) 1 ea engine accessory wiring harness

(7) 1 ea hose assy engine air intake

(8) All camshaft seals right bank

(9) Crankcase and transmission vent line hoses at connector

(10) All engine and transmission oil pressure and temperature sendint units

DATE	INSPECTOR
15 June 1976	[redacted]

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Equipment Malfunction/Failure Report (Fire Damage)
Recovery Vehicle, M88, SN 300, USA # 9B 5811

5. b. Hull items damaged:

(1) Wiring harnesses starter and master relays.

(2) Rear slave recepticle wiring harness.

(3) Vehicle rear light wiring harness

(4) 1 ea starter relay

(5) 1 ea master relay

(6) All hydraulic stayline pressure hoses

(7) 1 ea brake air cylinder

(8) 1 ea reduction unit left rear

(9) 2 ea fuel tank mounts

(10) 6 ea bearings, steering and shifting linkage

(11) 1 ea hose assy defueling pump to tank

(12) 1 ea liner assy w/insulation engine top deck assy

(13) Paint - engine compartment

c. Estimated manhours to repair: 200.

d. Estimated parts cost: $2,700.00.

e. Estimated total cost of repairs: $5,542.00.

f. Probable cause: Fuel leak ignited by an electrical short in the area of the starter and master relays.

g. Discrepancies noted during routine inspection of fire damaged vehicle:

(1) Fixed fire extinguisher not weighed since July 1974.

(2) Defective electrical wiring and electrical cannon plugs.

(3) Engine fire extinguisher line not properly modified.

Equipment Malfunction/Failure Report (Fire Damage)
Recovery Vehicle, M88, SN 300, USA # 9B 5811

5. g. (4) Engine compartment excessively oily.

(5) Auxillary engine exhaust pipe broken.

(6) Fuel filter full of water.

(7) Boot and retainer, auxillary transmission, and P.T.O. shaft cover missing.

(8) Water hose with wire clamps being used as a main fuel line, right fuel tank to fuel union block.

(9) Generator exhaust and air intake hoses crushed and not mounted properly.

(10) This vehicle was unsafe to operate.

[redacted]

[redacted]

APPENDIX B

TYPES OF VEHICLES FOR WHICH FIRES WERE REPORTED

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Appendix B consists of a list of the various vehicle types (and electric generator sets) which were involved in fires and subsequently considered in this report.

Often the vehicles were not specifically identified by Army nomenclature. In those cases, the vehicles were listed by the terms used in the fire reports from which the data came.

VEHICLE TYPES WITH MORE THAN FIVE REPORTED FIRES

M60/A1 - tank, combat, full tracked (FT), with a 105mm gun

M60A2 - tank, combat, FT, with a 152mm gun/launcher

M88 - vehicle, recovery, medium, FT

M551/A1 - AR/AAV (armored reconnaissance airborne assault vehicle), FT, with 152mm gun/launcher

M113/A1 - carrier, personnel, armored, FT

M35A2 - truck, cargo, 2 1/2 ton, 6x6

M151/A1/A2 - truck, utility, 1/4 ton, 4x4

M880/2/3 - truck, cargo, 5/4 ton, 4x4

M561(792) - truck, cargo, 5/4 ton, 6x6, "Gamma Goat"

VEHICLE TYPES WITH FEWER THAN FIVE REPORTED FIRES

M548 - carrier, cargo, armored, FT, 6-ton

M42 - gun, antiaircraft, self-propelled, FT, twin 40mm, "Duster"

M48 - tank, combat, FT, with a 90mm gun

M109/A1 - howitzwer, self-propelled, FT, 155mm

M728 - vehicle, engineer, combat, FT, with 165mm gun

M106 - carrier, mortar (107mm), self-propelled, FT

M116 - carrier, cargo, armored, amphibious, FT

M577 - carrier, (command post), armored, light, FT

XM1 - tank, combat, main battle, FT, with a 105mm gun

Bulldozer

Armored Personnel Carrier - probably an M113 series vehicle

VEHICLE TYPES WITH FEWER THAN FIVE REPORTED FIRES (CONTINUED)

Tracked Tractor

M52A2 - tractor, 5-ton, 6x6

M54/A1/A2 - truck, cargo, 5-ton, 6x6

M59A2 - **

M127 - semi-trailer, stake, 12-ton, 4 wheel

Semi-trailer

M706 - car, armored, light, 4x4

M715 - truck, cargo, 5/4 ton, 4x4

M757 - tractor, 5-ton, 8x8

M813/A1 - truck, cargo, 5-ton, 6x6

M818 - tractor, 5-ton, 6x6

M820 - van, 5-ton, 6x6

20-ton dump truck

7 1/2 ton truck

5-ton dump truck

5-ton truck

5-ton tractor

5-ton tractor (Dodge 600)

Fuel tanker

** The M59 is a 2 1/2 ton dump truck. In the fire report, the vehicle was described as being a 5-ton truck. The matter of this vehicle's correct identification is unresolved, but does not significantly affect the report statistsics or results.

VEHICLE TYPES WITH FEWER THAN FIVE REPORTED FIRES (CONTINUED)

2 1/2-ton cargo truck

2 1/2-ton personnel carrier

International Harvester truck

Computer van

Delivery truck

1-ton pick-up truck

3/4-ton tactical ambulanace

3/4-ton panel truck

1/2-ton pick-up truck

Dodge carryall

Plymouth sedan

Jeep

45 passenger bus

25 passenger bus

Loader/transporter, Hawk

Loader/transporter, Chapparral

Massey Ferguson tractor

Front end loader

Tow motor with 2 trailers

Undesignated vehicle

NON-VEHICLE FIRES CONSIDERED IN THIS REPORT

Electric generator sets - internal combustion powered portable electric generator sets, skid-mounted or trailer-mounted

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APPENDIX C

CODED DATA SHEETS WITH KEY

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Appendix C contains raw data obtained from the fire reports submitted to the OCE and the ASC.

The key for the coded data sheets is also enclosed in this appendix.

Vehicle	ID #	Install-ation	Cause of Fire	Location in Vehicle	Who Detected	How Extin-guished	FFES Have?	FFES Used?	FFES Work?	FFES Eff?	Cost $K	Injuries	Deaths
M60	7605	HD	1	EC	DR	FFES	✓	✓	✓	✓	5.7		
	7620	BG	1	EC	DR	FD	✓	✓	✓	X	4.0		
	7652*	CR	4	EC	CR	FD	✓	✓	✓	X	54.6		
	7653*	OC	3	EC	OM	FD	✓	✓	✓	X	17.4		
	7656*	BG	5	EC	CR	DIRT	✓	✓	✓	X	32.0		
	7657*	LW	5	EC	CR	FD	✓	✓	✓	X	255.5		
	7763A	HD	2	EC	CR	FFES	✓	✓	✓	✓	0.4		
	7769*	CR	2	CC	CM	FD	✓	U	NA		50.0		
	7770*	OC	2	CC	OM	PE	✓	X	NA		1.2		
	7771*	HD	3	EC	CM	FFES	✓	✓	✓	✓	9.0		
	7828	YK	1	EC	CR	FD	✓	✓	✓	X	65.0		
	7834B	DT	2	CC	CV	NONE	✓	X	NA		5.0		
M60A1	7601	BL	1	EC	CR	SAND	✓	✓	✓	X	90.0	1	
	7603+	BG	4	EC	CR	FD	✓	✓	✓	X	25.0		
	7607	HD	1	EC	OM	DIRT	✓	✓	✓	X	12.9		
	7608	CR	1	EC	U	FD	✓	✓	✓	X	2.0		
	7609	CR	5	EC	U	PE & FD	✓	U	NA		1.5		
	7610	OC	1	EC	CM	FD	✓	✓	✓	X	71.2		
	7612B	HD	2	OT	DR	FFES	✓	✓	✓	✓	1.1	2	
	7616	OC	2	OT	DR	PE	✓	✓	✓	X	0.2		
	7630	LT	2	CC	OM	FD	✓	X	NA		20.0		
	7648	HD	1	EC	CR	FD	✓	✓	✓	X	7.1		
	7722	OC	3	EC	CR	FD	✓	✓	✓	X	46.2		
	7758	HD	4	EC	CM	FD	✓	✓	X	NA	20.9		
	7774*	HD	5	EC	CR	PE & FD	✓	✓	✓	X	6.0		
	7776	HD	5	EC	CR	PE	✓	✓	✓	X	9.3		
	7778*	BG	5	EC	CR	U	✓	U	NA		85.0		
	7814	CR	1	EC	U	FD	✓	U	NA		4.7		
	7815	HD	1	EC	DR	FD	✓	✓	✓	X	4.4		
	7820	HD	4	EC	DR	PE	✓	✓	✓	X	5.2		
	7848	HD	4	EC	OM	PE	✓	X	NA		19.6		
	7852	RL	1	EC	DR	PE & FD	✓	✓	✓	X	1.1		
	7853	CR	2	EC	CR	PE & FD	✓	✓	✓	X	3.5	2	

*Vehicles unique to the ASC data source.

+It should be noted that the FFES extinguished the first fire, and that the engine was restarted after after about 5 minutes, resulting in a fire which could not be put out by the second shot of the FFES

Vehicle	ID #	Install-ation	Cause of Fire	Location in Vehicle	Who Detected	How Extin-guished	FFES Have?	FFES Used?	FFES Work?	FFES Eff?	Cost $K	Injuries	Deaths
M60A1	7864	CR	5	EC	U	FD	✓	U	NA		181.5		
(Cont'd)	7867*	HD	1	EC	CM	PE	✓	✓	X	NA	1.1		
	7870*	OC	1	EC	U	U	✓	U	NA		9.0		
	7919	CR	1	EC	CR	FD	✓	U	NA		78.0		
	7923	CR	1	EC	CR	FD	✓	U	NA		33.0		
	7926	HD	4	EC	DR	FD	✓	✓	X	NA	29.2		
	7933	RL	4	CC	CR	PE & WATER	✓	X	NA		2.4		
M60A2	7711	OC	2	CC	OM	PE	✓	X	NA		0.3		
	7777*	OC	2	CC	CR	PE	✓	U	NA		1.7		
	7931	OC	2	CC	DR	FD	✓	✓	X	NA	0.5		
M88	7606	HD	3	EC	CM	FFES & PE	✓	✓	✓	✓	0.9		
	7611	RL	4	EC	CR	FD	✓	✓	X	NA	8.6		
	7614	HD	1	EC	CR	FD	✓	✓	X	NA	5.5		
	7615	OC	1	EC	CR	FD	✓	✓	X	NA	187.2		
	7637	BL	1	EC	DR	FD	✓	U	NA		565.0		
	7642	OC	3	EC	CR	FD	✓	U	NA		22.5		
	7645	OC	4	EC	OM	FD	✓	X	NA		9.1		
	7659*	HD	1	EC	DR	U	✓	✓	✓	X	11.6		
	7710	HD	4	EC	DR	FD	✓	✓	X	NA	39.2		
	7714	HD	1	EC	CM	FD	✓	✓	✓	X	42.0		
	7720	AP	5	EC	DR	FD	✓	✓	✓	X	1.2		
	7724	KX	4	EC	CR	FD	✓	X	NA		0.7		
	7726	CR	5	U	CR	FD	✓	✓	✓	X	199.9		
	7732	CR	3	EC	DR	FD	✓	X	NA		15.4		
	7733	HD	4	EC	DR	FFES & FD	✓	✓	✓	✓	36.8		
	7735	HD	1	EC	DR	FD	✓	✓	✓	X	149.2	1	
	7759	HD	1	EC	DR	FD	✓	✓	✓	X	76.4		
	7810	KX	3	EC	CR	FFES & PE	✓	✓	✓	✓	7.8		
	7813A	CR	3	EC	CR	FD	✓	U	NA		33.6		
	7819	HD	4	EC	DR	FD	✓	✓	✓	X	16.9		
	7830	KX	1	EC	CR	FFES	✓	✓	✓	✓	5.1		
	7831	HD	1	EC	DR	FD	✓	✓	U	NA	103.4		
	7832	HD	1	EC	CR	FD	✓	✓	✓	X	12.6	1	
	7833	HD	4	EC	OM	FD	✓	✓	✓	X	1.9		

Vehicle	ID #	Install-ation	Cause of Fire	Location in Vehicle	Who Detected	How Extin-guished	FFES Have?	FFES Used?	FFES Work?	FFES Eff?	Cost $K	Injuries	Deaths
M88	7843	OC	1	EC	OM	FD	✓	U	NA		4.8	1	
(Cont'd)	7844	KX	3	EC	OM	FFES	✓	✓	✓	✓	0.5		
	7849	DM	3	EC	CR	FD	✓	X	NA		50.1	2	
	7860	OC	1	EC	CR	FD	✓	X	NA		60.0		
	7868*	ST	2	EC	OM	FFES	✓	✓	✓	✓	0.8		
	7908	DM	1	CC	CM	PE & SNOU	✓	✓	✓	X	60.0		
	7929	YK	1	EC	DR	FD	✓	U	NA		10.8		
M551	7617+	OC	2	CC	CR	FD	✓	X	NA		600.0		
	7636	HD	3	EC	CR	PE	✓	✓	X	NA	2.7		
	7742	KX	4	CC	CR	FFES	✓	✓	✓	✓	0.5		
	7748	BL	2	CC	CM	FD	✓	✓	✓	X	280.0		
	7817	BR	5	CC	CR	FD	✓	✓	✓	X	151.3		
	7851	KX	4	CC	DR	NONE	✓	✓	✓	X	39.0		
M551A1	7604	OC	2	CC	CR	FD	✓	✓	✓	X	238.0		
	7612A	OC	2	CC	CM	FD	✓	✓	✓	X	1.6		
	7613	OC	2	CC	CR	FD	✓	✓	U	NA	235.6		
	7658*	OC	2	CC	CR	PE	✓	✓	X	NA	0.3		
	7743	OC	2	CC	CR	FD	✓	✓	✓	X	232.0		
	7765	OC	1	EC	CR	FD	✓	✓	X	NA	18.0		
	7773*	HD	2	CC	OM	U	✓	U	NA		10.9		

+This vehicle was totally destroyed. However, damage cost estimates for other totally destroyed vehicles of this type were less than one half of this estimate. The reason for the extreme difference in the cost estimates is unknown.

Vehicle	ID #	Install-ation	Cause of Fire	Location in Vehicle	Who Detected	How Extin-guished	FFES Have?	FFES Used?	FFES Work?	FFES Eff?	Cost $K	Injuries	Deaths
M113	7633	OC	2	CC	OM	FD	✓	X	NA		1.7		
	7654*	GY	1	EC	DR	U	✓	U	NA		6.0	1	
	7655*	OC	4	CC	DR	U	✓	U	NA		0.3		
	7712	RL	4	EC	OM	FD	✓	X	NA		12.1	1	
	7716	RL	3	CC	DR	PE	✓	U	NA		0.7	1	
	7871*	RL	5	EC	DR	WATER	✓	✓	✓	X	0.8		
M113A1	7625	YK	4	OT	CR	U	✓	U	NA		108.2	3	
	7650	HD	2	CC	CR	PE & DIRT	✓	X	NA		4.1		
	7706	OC	4	CC	CR	FD	✓	U	NA		46.0		
	7760	OC	1	CC	CR	FD	✓	✓	✓	X	98.4	1	
	7768*	OC	4	CC	CR	U	✓	U	NA		121.7		
M35A2	7634	OC	1	CA	CR	WATER & FD	X	NA			3.1		
	7704	RL	3	EC	DR	FD	X	NA			8.4		
	7708	OC	1	CA	OM	FD	X	NA			16.0		
	7739	HD	4	CA	OM	FD	X	NA			22.5		
	7754	OC	4	CA	OM	PE	X	NA			0.6		
	7767	OC	4	CA	OM	FD	X	NA			3.7		
	7804	WT	3	EC	DR	FD	X	NA			3.0		
	7805	OC	5	U	CV	FD	X	NA			0.4		
	7901	OC	1	CA	CR	FD	X	NA			6.1		
	7921	OC	1	CA	CR	FD	X	NA			22.4		
M151	7703	HA	4	OT	DR	FD	X	NA			3.2		
	7816	GY	3	CC	DR	FD	X	NA			1.5		
	7913	OC	4	OT	DR	PE	X	NA			0.3		
M151A1	7902	WT	3	CC	OM	FD	X	NA			2.5		
	7915	WT	3	CC	DR	PE & SNOW	X	NA			0.3		
M151A2	7729B	OC	5	CC	OM	PE & FD	X	NA			0.4		
	7736	YK	4	OT	CR	FD	X	NA			6.7		
	7807	GY	3	CC	DR	FD	X	NA			4.1		
	7855	LT	4	OT	DR	FD	X	NA			3.2		
	7905	RN	3	CC	DR	NONE	X	NA			7.8		

Vehicle	ID #	Install-ation	Cause of Fire	Location in Vehicle	Who Detected	How Extin-guished	FFES Have?	FFES Used?	FFES Work?	FFES Eff?	Cost $K	Injuries	Deaths
M880	7632	OC	4	CA	OM	FD	X	NA			4.6		
	7842	OC	5	CA	DR	FD	X	NA			81.7		
M882	7847	DM	4	CA	DR	FD	X	NA			0.6		
	7756A	OC	4	CA	CV	FD	X	NA			15.9		
	7904	WT	3	CC	DR	FD	X	NA			9.0		
	7907	WT	4	CA	DR	FD	X	NA			6.3		
M883	7910	OC	4	CA	DR	FD	X	NA			4.0		
M561	7629	YK	4	OT	DR	FD	X	NA			17.4		
	7639	OC	2	CC	OM	FD	X	NA			8.3		
	7713	OC	4	CA	DR	FD	X	NA			15.3		
	7912	GY	3	CC	CR	FD	X	NA			1.2		
	7920	OC	4	CA	OM	FD	X	NA			6.7		
M561(792)	7906	WT	5	CA	OM	PE & SNOW	X	NA			6.0		
M548	7602	OC	1	EC	DR	FD	✓	✓	X	NA	1.6	1	
	7857	OC	4	EC	DR	FD	✓	X	NA		16.3	2	
	7861	OC	4	CC	CR	FD	✓	X	NA		5.6	1	
M42	7734	BL	1	EC	DR	FD	✓	✓	X	NA	1.2		
M42A1	7869*	BD	5	EC	U	U	✓	U	NA		116.2		
M48	7738	HD	1	EC	CR	FD	✓	✓	✓	X	46.8		
	7859	RA	1	CC	DR	FD	✓	X	NA		0.5		
M109	7772*	SL	4	CC	CR	U	✓	U	NA		3.2	3	
M109A1	7731	HD	5	U	OM	FD	✓	X	NA		18.7		
M728	7717	RL	1	EC	CR	FD	✓	✓	X	NA	1.6		
	7872*	OC	2	CC	CR	DIS BATT	✓	✓	X	NA	2.5	1	
M106	7727	HD	4	CC	CR	PE	✓	X	NA		0.7	3	1

Vehicle	ID #	Install-ation	Cause of Fire	Location in Vehicle	Who Detected	How Extin-guished	FFES Have?	FFES Used?	FFES Work?	FFES Eff?	Cost $K	Injuries	Deaths
M116	7928	GY	1	EC	DR	FD	X	NA			16.0		
M577	7775*	OC	4	OT	CR	U	✓	X	NA		1.5	1	
M577A1	7866*	OC	4	CC	OM	U	✓	U	NA		65.5		
XM1	7918	AP	1	EC	DR	FD	✓	✓	X	NA	5.0		
Bulldozer	7647	SN	2	EC	DR	FD	X	NA			0.7		
	7705	BR	4	EC	DR	FD	X	NA			5.0		
	7753	SH	1	EC	DR	PE	X	NA			3.1		
Armored Per. Car.†	7917	CF	5	CC	CR	FD	U	NA			4.7		
Tracked Tractor	7826	BR	4	U	DR	FD	X	NA			3.5		
M54A1	7623	OC	3	EC	OM	PE	X	NA			0.3		
M54A2	7721	OC	3	EC	DR	FD	X	NA			14.6		
M52A2	7803	DX	2	EC	DR	FD	X	NA			12.6		
M59A2	7821	OC	4	CA	DR	FD	X	NA			17.0		
M127 Trailer	7752	OC	3	CA	DR	FD	X	NA			8.8		
Semi Trailer	7911	BG	3	CA	OM	FD	X	NA			5.2		
M706	7903	UD	2	EC	OM	FD	X	NA			11.3		
M715	7631	OC	3	OT	DR	FD	X	NA			4.1		
	7646	OC	4	EC	OM	PE & FD	X	NA			1.6	1	
M813	7932	OC	4	CA	DR	FD	X	NA			7.1		
M813A1	7802	OC	4	CA	DR	FD	X	NA			17.0		

† Probably an M113 series APC

Vehicle	ID #	Install-ation	Cause of Fire	Location in Vehicle	Who Detected	How Extin-guished	FIFS Have?	FIFS Used?	FIFS Work?	FIFS Eff?	Cost $K	Injuries	Deaths
M757	7812	OC	1	EC	DR	FD	X	NA			19.9		
M818	7641	OC	4	CA	CV	FD	X	NA			16.8		
	7749	OC	3	CA	DR	FD	X	NA			0.5		
M820	7914	HD	2	CA	OM	FD	X	NA			206.8	1	
20-ton Dump Truck	7747B	LT	4	OT	OM	FD	X	NA			3.5		
	7838	OM	4	U	OM	FD & PE	X	NA			13.0		
	7924	HD	4	CA	DR	FD	X	NA			0.9		
7 1/2-ton Truck	7764	OC	4	CA	U	FD	X	NA			21.9		
5-ton Dump Truck	7840	BR	1	EC	DR	FD	X	NA			4.6		
5-ton Truck	7834A	ME	1	CA	OM	FD	X	NA			5.0		
5-ton Tractor	7728	OM	5	EC	DR	PE & FD	X	NA			5.0		
Dodge 600, 5-ton Cargo Truck	7719	OC	4	CA	CV	FD	X	NA			10.5	1	
Fuel Tanker	7837	PK	4	CA	DR	FD	X	NA			106.8		
2 1/2-ton Cargo Truck	7865	OC	3	EC	DR	FD	X	NA			19.0		
2 1/2-ton Personnel Car.	7745	GY	2	CA	OM	FD	X	NA			1.2		
Internat'l Har. Truck	7626	OC	4	CA	DR	FD	X	NA			9.2		
Computer Van	7756B	OC	3	CA	OM	PE	X	NA			0.8		

Vehicle	ID #	Install-ation	Cause of Fire	Location in Vehicle	Who Detected	How Extin-guished	FFES Have?	FFES Used?	FFES Work?	FFES Eff?	Cost $K	Injuries	Deaths
Maintenance Truck	7835	OC	4	CA	CV	FD	X	NA			1.4		
1-ton Pick-Up Truck	7858	MC	2	EC	CV	PE	X	NA			0.3		
	7709	BG	2	CC	OM	FD	X	NA			8.7		
3/4-ton Tactical Ambulance	7628	JK	5	U	OM	FD	X	NA			8.9		
3/4-ton Panel Truck	7763B	OC	1	EC	DR	FD	X	NA			0.6		
1/2-ton Pick-Up Truck	7730	LW	4	CA	CV	FD	X	NA			1.1		
	7741	LW	4	EC	OM	PE	X	NA			0.8		
	7651	AP	4	OT	DR	FD	X	NA			0.4		
	7916	GM	4	OT	DR	FD	X	NA			0.9		
Dodge Carryall	7762	OC	4	CC	DR	FD	X	NA			0.6		
	7638	OC	1	EC	DR	FD	X	NA			2.5		
Plymouth Sedan	7618	OC	5	U	CV	FD	X	NA			3.9		
Jeep	7715	WT	3	CC	DR	FD	X	NA			3.1		
	7846	OC	4	EC	DR	PE	X	NA			5.0		
	7850	TO	4	EC	CV	RAGS	X	NA			0.5	1	
	7927	RN	3	CC	DR	PE & FD	X	NA			0.6		
45 Passenger Bus	7718A	BG	1	EC	DR	FD	X	NA			2.9		
25 Passenger Bus	7811	OC	1	EC	DR	FD	X	NA			1.0		
Chappararal G.M. Carrier	7746	OC	1	OT	OM	FFES	✓	✓	✓	✓	32.0		
Hawk G.M. Loader/ Transporter	7740	OC	4	EC	DR	FD	X	NA			89.5		

Vehicle	ID #	Install-ation	Cause of Fire	Location in Vehicle	Who Detected	How Extin-guished	FFES Have?	FFES Used?	FFES Work?	FFES Eff?	Cost $K	Injuries	Deaths
Massey Ferguson Tractor	7619	OC	4	EC	DR	FD	X	NA			0.8		
Front End Loader	7644	WT	2	OT	OM	PE & FD	X	NA			1.0		
Tow Motor w/2 Trailers	7635	LH	4	U	DR	FD	X	NA			1.7		
Undesignated Vehicle	7624	RN	1	EC	DR	FD	X	NA			0.5		
Generator Set, Electric	7621	LT	4		OM	FD	X	NA			6.4		
	7622	AH	4		OM	DIRT	X	NA			1.7		
	7640	OC	4		OM	FD	X	NA			3.1		
	7643	RL	4		CR	FD	X	NA			6.2		
	7723	OC	4		CR	FD	X	NA			11.4		
	7729A	OC	4		DR	FD	X	NA			7.0		
	7737	HD	4		DR	PE	X	NA			10.6		
	7747A	HD	4		OM	DIRT & FD	X	NA			4.5		
	7750	DN	4		OM	FD	X	NA			100.0		
	7801	OC	2		CR	FD	X	NA			2.5		
	7806	HD	4		OM	FD	X	NA			8.7		
	7809	OC	4		CR	SNOW & PE	X	NA			U	1	
	7813B	HA	3		DR	FD	X	NA			14.9		
	7818	OM	4		DR	FD	X	NA			4.3		
	7823	RL	4		CR	PE & FD	X	NA			1.5		
	7825	BG	4		CR	FD	X	NA			7.0	1	
	7827	HD	4		CR	FD	X	NA			8.5		
	7829	PK	4		CR	PE	X	NA			1.8		
	7836	OC	4		CR	FD	X	NA			28.5		
	7854	HD	4		OM	PE & WATER	X	NA			10.6	1	
	7863	RN	4		OM	PE	X	NA			2.9		
	7930	BG	4		OM	FD	X	NA			10.8		

KEY TO CODED DATA SHEETS

I. Installation Codes

AP - Aberdeen Proving Ground
DT - Detroit Tank Arsenal
LH - Longhorn Army Ammunition Plant
OC - OCONUS
RA - Redstone Arsenal
SH - Savannah Army Depot Activity
TO - Tooele Army Depot
UD - Umatilla Depot Activity
YK - Yakima Firing Center

AH - Fort A. P. Hill
BG - Fort Benning
BL - Fort Bliss
BR - Fort Bragg
CM - Fort Campbell
CR - Fort Carson
CF - Fort Chaffee
DN - Fort Devens
DX - Fort Dix
DM - Fort Drum
GM - Fort Gillem
GY - Fort Greely
HD - Fort Hood
SN - Fort Sam Houston
HA - Fort Huachuca
JK - Fort Jackson
KX - Fort Knox
LT - Fort Hunter Ligget
LW - Fort Leonard Wood
MC - Fort McCoy
ME - Fort George C. Meade
PK - Fort Polk
RN - Fort Richardson
RL - Fort Riley
SL - Fort Sill
ST - Fort Stewart
WT - Fort Wainwright

II. Cause Codes

1 - Fuel
2 - Electrical
3 - Mechanical Failure
4 - Human Error
5 - Unknown, Arson, Other

III. Location Codes

EC - Engine Compartment
CC - Crew Compartment (includes the turret in applicable vehicles)
CA - Cargo Area
OT - Other
U - Unknown

IV. Persons Responsible for Discovery of the Fire

CR - Crew
CM - Vehicle Commander
DR - Driver
OM - Other Military
CV - Civilian
U - Unknown

V. Agent Primarily Responsible for Extinguishing the Fire

FD - Fire Department
PE - Portable Fire Extinguisher
FFES - Fixed Fire Extinguishing System
U - Unknown
None - Fire Burned Itself Out
DIS BATT - Disconnected the Battery
Others as listed, e.g., SAND, WATER, etc.

VI. FFES - Fixed Fire Extinguishing System

Have? Did the vehicle have an FFES?
Used? Was there an attempt to use the FFES on applicable vehicles?
Work? When engaged, did the FFES function properly?
Eff? When used, did the FFES extinguish the fire?

✓ - yes, X - no, U - unknown, NA - not applicable

VII. Cost

The estimated damage costs are shown in thousands of dollars.

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